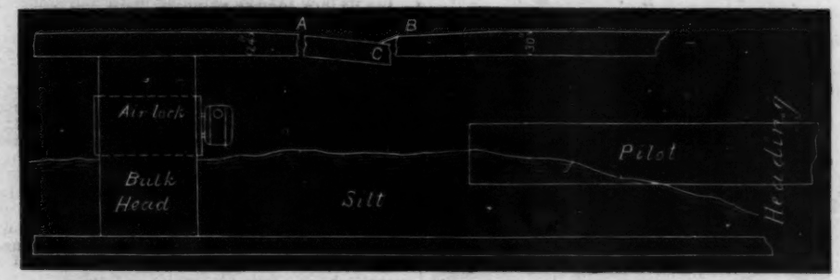
PROGRESS OF THE WORK ON THE HUDSON RIVER TUNNEL.

On Tuesday last we visited the New York terminus of the tunnel to note the progress which had been made with the caisson described in ENGINEERING NEWS of Dec. 24, 1881.

Upon entering the boarded enclosure at the foot of Morton street the first objects the eye rested upon were two large piles of brick, and the conclusion was quickly formed that the work on this side was progressing most favorably and rapidly. A closer inspection revealed the fact that these piles were only used as weights to keep the caisson down. Between them was a shaft leading down to the supply lock on top of the caisson, the material being raised and lowered by a small steam-engine located near the river side of the shaft. Descending two short flight of steps, the "passenger" air-lock was reached at the top of an iron shaft extending to the interior, means of locomotion being provided in the shape of ladders fastened to the sides. This lock is similar to the one used for some time on the other side, and with which our readers are familiar.

The inverts for the two tunnels are finished, and the sides and dividing wall completed for about 2 ft. above the interior of the bottom. In the center of the dividing wall, and at equal distances apart, are three iron pipes 1 ft. in diameter, and extending vertically from the interior of the caisson 6 ft. below the bottom of the invert. These pipes are about one-half full of broken stone, and terminate in oblong perforated boxes reaching to the masonry, and also filled with stone. The cement is mixed one to one and one to two, according to quality, while pure cement alone is used around the pipes. This cassion is sunk in a bed of sand, which extends toward the other shore for 200 or 250 ft.

The problem which now perplexes those in charge is how to cut through the side and start the tunnel proper. The first experiment to be tried will be to connect the vertical pipes with powerful pumping machinery and ascertain if the water can be drawn from the side through which it is designed to cut. The opening in the caisson on the other side of the river, opposite the south tunnel, was only made after sufficient silt had been rammed through a small hole to render the outside silt of the required consistency to hold the air. But this caisson being sunk in sand, the whole aspect of affairs is changed. Moreover, it has been found that the sand will follow the water into the caisson upon the diminution of the air pressure, which on Tuesday was 26 pounds per square inch.



LONGITUDINAL SECTION THROUGH SECOND AIR LOCK.

On the following day we visited the work at the New Jersey end, and noted several changes that had been made since the visit by the members of the American Society of Civil Engineers. Work upon the south tunnel has been stopped for the present on account of a lack of facilities for handling the material. An elevator has been placed in the shaft, and as the cars are brought up the tunnel they are run upon the platform, raised to the surface, and run upon a track leading to low lands back of the works. Walking down the north tunnel, we soon came to the bulkhead containing two air-locks, one of which was designed to be always opened toward the heading, thus affording a sure retreat for the men in case of accident. Entering this, we were soon under a pressure of about 25 lbs. to the square inch, when we emerged into the second stretch of completed work. About 300 ft. from this bulkhead is a second, which is furnished with but *one* air-lock. Entering this, we were subjected to a still further increase of pressure, and came out about 40 ft. from the heading. According to the mercury gauge, which we consulted after coming to the surface, the pressure in this section of the work was between 32 and 33 lbs. to the square inch.

All the material is lowered by the elevator, run down to the first set of air-locks, passed through, drawn by a horse (we may state of this animal that he stands the pressure well, eats heartily and is gaining in flesh, and that he has almost recovered from the heaves from which he suffered when first admitted) to the second lock through which it passes to the men. The entire tunnel has been kept a little over half full of excavated silt, which will be removed after the approach shall have been completed.

About 10 ft. from the interior end of the second bulkhead a break is perceived in the roof, and the 10 ft. beyond this slope rapidly downward until the far end is about 13 in. from the grade line. The 10-ft. section adjoining this is commenced on grade and so continued. The accompanying sketch will aid in understanding the work. The top of the tunnel had been finished to *A* on grade, but when the iron plates were put in place for the next section a settlement took place which resulted in a deflection at *B* of about 18 in., and left an uneven opening at *A* sufficiently large in some places to thrust in the hand. The next section, commencing at *B*, was started on grade and so finished. The opening at *B*, between the ends of the masonry, is large enough for a man to crawl into. In order to keep the silt back short boards and plates have been inserted from *B* to *C*. The section beginning at *B* has been finished, and work is now in progress on the next one. We were informed that the grade of the lower portion of the tunnel had been kept true. To strengthen the tunnel the arch is now being made 2½ ft. thick, the increase being made as shown in the drawing.

After completing the section now being built, that portion between *A* and *B* will be removed and rebuilt on the proper grade. This settling seems to have resulted from the failure of the surrounding silt to hold the air, and the two following sections were begun in order that it might have time to attain the requisite consistency. The work at the heading is carried on in the manner so frequently described.

All the work completed since the accident of 1880, from about 300 ft. from the shaft to the second air-lock, presents the appearance of excellent workmanship. The grade has been kept, with the exception of that section above described, and the interior surface is straight and regular.

The tunnel is lighted by electricity furnished by two dynamo machines located in the engine-room, the lights being so distributed as to illumine the work from the shaft to the heading.

In an undertaking of this description much depends upon the class of workmen employed, and the class in turn depends upon the wages paid. The masons get from $3.50 to $4, and the laborers and helpers from $1.50 to $2.25. At present each shift works eight hours, with a one-half hour rest outside.

Almost every man has had an attack of the "bends," although no very serious cases have as yet occurred. Strict rules have been found necessary for the good of the men. Every new man is examined for heart or lung trouble by the surgeon of the company. It is compulsory for the men when entering to use the elevator in preference to the stairs leading to the bottom of the shaft. Hot coffee is sent into the tunnel just before the time for coming out. All violent exercise is discouraged, the use of spiritous liquors prohibited, and regular habits recommended.

RECENT INVENTIONS.

A novel means for transporting and delivering dredged material from the bed of shallow waters upon the river-flats is as follows: A scow or lighter provided with railway tracks, and having dumping cars thereon, is towed to a dredging machine in position for operation, and the cars are filled by the dredger. The lighter is then towed to a landing-pier, with which it is connected by means of a floating bridge provided with a railway track, and supported on another scow or lighter. The bridge is hinged at the center, on a raised support on the scow, and its outer ends are supported by weighted levers, the fulcrums of which are supported by standards at the corners of the scow. When in position the inner end of the bridge rests on the pier, and the outer end on the loaded scow. A locomotive is then taken down the pier and over the bridge and coupled to the dumping-cars, which are drawn off to the desired place and dumped, and are then returned to the lighter to be reloaded. The pier has two or more tracks of different grades of inclination extending back to a common track; and the floating bridge, with its track, is shifted laterally to connect with the several tracks, according to the state of the tide.

A new draw-bridge guard consists of vertically sliding barriers, arranged at either end of the draw-span to close the thoroughfare leading to it when the draw is open, and which, in their normal positions, are raised above the tops of passing vehicles. Counterweights, running over pulleys, are employed which are heavier than the barriers. Auxiliary weights are so arranged as to slide the barriers in a position to block the highway when the draw is open, and which, at any time, can be tripped by the swinging bridge, or independently thereof, regardless of the position of the span, to allow the barrier to rise. These auxiliary weights, when brought into service, give the barriers the balance of power, and thus overcome the counterweight, causing the barriers to descend. The upward and downward movements are initiated by the swinging bridge.

The following invention is designed to protect bridge-piers, docks, etc., from the lodgement of floating drift matter, by a vertically-moving wheel or cylinder, having a barbed outer surface. This wheel is located (up stream) in front of the pier, or object to be shielded. The force of the current causes the floating object to rotate the wheel, thereby deflecting it and causing it to pass on. Means for rotating the wheel by hand are provided when desired.

A late foreign invention patented in England by a Frenchman, has for its object to produce an instrument for use by surveyors, architects, builders, etc., either as a spirit level or as a pencil. For this purpose a tube, preferably circular or elliptic in cross section, is used, into which a pencil and pencil-case with movable lead is introduced. This tube has on the upper side one or two openings closed with glass, and it is filled with suitable liquid having a bubble of air for observation through the openings. The pencil-case passes into or through the liquid, or the tube may have a lateral recess for the pencil-case. The liquid receptacle may be made of glass or crystal, and surrounded with a metallic sleeve which forms the pencil-case. Provision is made providing the tube with a scale to denote inches, centimeters, etc.

A novel excavator has a series of rotating picks which loosen the earth to be excavated. These picks are arranged upon endless traveling chains, which pass over suitable forward and rear pulleys supported upon a wheeled frame. A series of rotating shovel-buckets are also secured to the endless chains, which take up the loosened earth and elevate it to the desired point. Swinging bottoms to the buckets accommodate the action of a cleaning scraper.

Another late invention in excavators consists of a wheel having a series of radially and circumferentially arranged buckets of the following construction: The vertical cutting edges of the sides of the bucket convey from the top toward the cutting edge of the bottom, presenting with said bottom edge an outline similar to a truncated wedge; and the edges, as they extend rearward toward the upwardly curved bottom, converge rearward. The effect of this construction is that in excavating the cutting edges cut a ditch of greater depth and width than the body of the bucket, this giving the bucket free and easy clearance in the ditch, while the enlargement of the bucket toward the top gives the earth free clearance therefrom as the bucket is revolved. The bottom of the bucket is extended above the sides, in the form of a mold-board of a plow, to throw the earth out laterally.

WASHINGTON, D. C. F. B. BROCK.

RELATIVE NON-CONDUCTIVITY.

Mr. Charles E. Emery, of this city, recently made some experiments upon relative non-conductivity, with reference to the needs of the New York Steam Company. His apparatus consisted of a boiler 12 ft. long and 4 ft. in diameter, with three 10-in. flues passing through it. Inside these flues were smaller tubes, through which the steam passed. The non-conductors surrounded the inner tubes, and water was kept circulating around the flues in the outer shell. A layer of hair felt 2 in. thick gave the best result, and, using equal thicknesses of the other materials, the following results were obtained:

Material.	Non-conductivity. Per cent.
Hair felt	100
Mineral wool, No. 2	83.2
Mineral wool, No. 2 and tar	71.5
Sawdust	68
Mineral wool, No. 1	67.6
Charcoal	63.2
Pine wood, across grain	55.3
Loam	55
Gas-works lime, slaked	48
Asbestos	36.3
Coal ashes	34.5
Fuel coke	27.7
Air space, 2 inches deep	13.6

The low result from air space no doubt is due to the unimpeded circulation of the currents.

CORRESPONDENCE.

SPIRAL CURVES.

T. I. O. R. R., JALTIPAN, MEXICO, Jan. 18, 1882.

EDITOR ENGINEERING NEWS:

The following communication about "spiral curves" for the easing of circular curves at the points of tangent, and laid out with the transit by the ordinary method, might be interesting.

In the accompanying figure let AO and OA' be two located tangents with angle of intersection I. Suppose $BLL'B'$ a circular curve with radius R located to fit these tangents, so as to have the tangent points at B and B'.

For the easing of this circular curve at the tangent points, it is required to begin at a point A on the tangent, at a certain distance back of tangent point B, and lay out a curve which shall commence at A with a radius of curvature equal to infinity, and as we proceed towards B the radius of curvature gradually to diminish until it equals that of the circular curve $BLL'B'$.

The deflection angle per unit length of chord to such a curve will be zero at A, and gradually increase to the end of the curve, where it will be equal to that of the circular curve $BLL'B'$.

Let the length of the easement curve or spiral be l, and let it be divided into any number of convenient stations n, then the length of each station will be $\frac{l}{n}$.

If a is the deflection angle per unit chord of circular curve $BLL'B'$ and x be the deflection angle of a chord $\frac{l}{n}$ of same curve, we have

$$\text{(I.)}\quad x = \frac{al}{n}.$$

Let d be a certain differential. The deflection angle between A and first station of spiral is assumed to be the nth part of x, then the deflection angle between first and second stations of spiral is to be greater than that between A and first station by the differential d, and the deflection angle between second and third stations is to be greater than that between first and second stations by $2d$, and that between third and fourth greater than that between second and third by $3d$, etc.

Following this process, the deflection angle between the last two stations of the spiral should be equal to x, so that the spiral and circular curves shall have the same radius of curvature at the last station of spiral where it is to join into the circular curve.

Hence we have

(II.) Deflection angle between A and first station $= \frac{x}{n}$.

Deflection angle between first and second stations $= \frac{x}{n} + d$.

Deflection angle between second and third stations $= \left(\frac{x}{n} + d\right) + 2d = \frac{x}{n} + 3d$.

Deflection angle between third and fourth stations $= \left(\frac{x}{n} + 3d\right) + 3d = \frac{x}{n} + 6d$.

Deflection angle between fourth and fifth stations $= \left(\frac{x}{n} + 6d\right) + 4d = \frac{x}{n} + 10d$.

Deflection angle between $(n-1)$th and nth stations $= \frac{x}{n} + \frac{n(n-1)d}{2}$.

By what we have said before, the last equation is to be equal to x, hence we have

$$\frac{x}{n} + \frac{n(n-1)}{2} d = x.$$

$$\text{(III.)}\quad \therefore d = \frac{2x}{n^2}.$$

By substituting this value of d in set of formulæ (II.) we have

(IV.) Deflection angle between A and first station $= \frac{x}{n}$.

Deflection angle between first and second stations $= \frac{x}{n} + \frac{2x}{n^2}$.

Deflection angle between second and third stations $= \frac{x}{n} + \frac{6x}{n^2}$.

Deflection angle between third and fourth stations $= \frac{x}{n} + \frac{12x}{n^2}$.

Deflection angle between fourth and fifth sections $= \frac{x}{n} + \frac{20x}{n^2}$.

Deflection angle between $(n-1)$th and nth stations $= \frac{x}{n} + \frac{n(n-1)}{2} \frac{2x}{n^2} = x$.

The deflection angle from A to 1st station of spiral will be the first equation of set (IV.); the deflection angle from A to second station will be the sum of the first two equations of set (IV.), that from A to third station the sum of the first three equations, and the deflection angle from A to mth station will be the sum of the first m equations of set (IV.) These angles we shall call the total deflection angles for each station.

Hence we have total deflection angle for mth station

$$= \frac{mx}{n} + \tfrac{1}{3}(m-1)\, m\, (m+1)\frac{x}{n^2}$$

Substituting the value of x given in equation (I.) we have

(V.) Total deflection angle for station mth

$$= \frac{mal}{n^2}\left\{1 + \tfrac{1}{3}\left(\frac{m^2-1}{n}\right)\right\}$$

The total deflection angle of the spiral is obtained by making $m = n$ in equation (V.), which gives us if we call this angle φ

$$\text{(VI.)}\quad \varphi = \frac{al}{n}\left\{1 + \tfrac{1}{3}\left(\frac{n^2-1}{n}\right)\right\}$$

We have now to determine at what distance back of tangent point B of circular curve $BLL'B'$ the point A should be situated, so that the deflection angle, for a portion of the circular curve $BLL'B'$ equal in length to that part of the spiral mn which lies inside the tangent point B, shall equal the total deflection angle of spiral.

Call the length of that portion of the spiral from m to n, l'.

As a is deflection angle per unit of circular curve $BLL'B'$, the deflection angle of a portion of same curve equal in length to l' is al'; this angle has to be equal to the total deflection angle of spiral given in equation (VI.)

Hence we have $al' = \frac{al}{n}\left(1 + \frac{1}{3}\frac{n^2-1}{n}\right)$

$$\text{(VII.)}\quad \therefore l' = \frac{l}{n}\left(1 + \tfrac{1}{3}\frac{n^2-1}{n}\right)$$

The distance back of tangent point B, where A should be situated is $l - l'$.

As in equation (VII.), l and n being constant,

l' is also constant, we see that for a given length of spiral divided into a given number of stations, the point A is always at a constant distance back of the tangent point B, no matter what the radius of the circular curve $BLL'B'$ may be; also the portion of the spiral mn, which lies inside tangent point B, is constant.

It will be noticed that, as the total deflection angle of the spiral is equal to the deflection angle of $BL = l'$ of circular curve $BLL'B'$, and as the spiral is considerably longer, the end of the spiral will be a little inside the original circular curve $BLL'B'$.

Therefore, between the ends n and n' of spirals An and $A'n'$, a circular curve nn' has to be run in, which is concentric with circular curve $BLL'B'$.

This displacement of original circular curve $BLL'B'$ is so small that the radius of circular curve nn', in practice, is assured to be equal to that of original circular curve $BLL'B'$, and run in accordingly.

This displacement is equal to $NS - LS$, but NS = length of spiral times the sine of half the total angle of deflection of spiral approximately, and LS equals BL or Mn or l' times the sine of half the angle of deflection of portion BL of circular curve $BLL'B'$ approximately. These angles being both equal to φ_2, we have

Displacement or $R - R' = l - l' \sin. \varphi_2$

Substituting for l' its value given in equation (VII.) we have

$$\text{(VIII.)}\quad R - R' = \frac{l}{n}\left(1 + \tfrac{1}{3}\frac{(n^2-1)}{n}\right) \sin. \varphi_2$$

R', being the radius of circular curve nn', and φ to be obtained from equation (VI.).

In practice, a length of spiral divided into any number of stations which is thought best is adopted.

When the length of spiral is adopted, it is to be unchangeable for all the circular curves used, irrespective of the radii of such circular curves.

Let us here adopt a spiral 100 ft. long divided into 10 stations. Then $l = 100$ and $n = 10$.

Formula (I.) becomes

$$\text{(IX.)}\quad x = 10a.$$

Set of formulæ (III.) become

(X.) Deflection angle between A and 1st station $= a$
" " " 1st and 2d stations $= 1.2\ a$
" " " 2d and 3d stations $= 1.6\ a$
" " " 3d and 4th stations $= 2.2\ a$
" " " 4th and 5th stations $= 3\ a$
" " " 5th and 6th stations $= 4\ a$
" " " 6th and 7th stations $= 5.2\ a$
" " " 7th and 8th stations $= 6.6\ a$
" " " 8th and 9th stations $= 8.2\ a$
" " " 9th and 10th stations $= 10\ a$

We then have—

Total deflection angle from A to 1st station $= a$.
" " " A to 2d station $= 2.2\ a$.
" " " A to 3d station $= 3.8\ a$.
" " " A to 4th station $= 6\ a$.
" " " A to 5th station $= 9\ a$.
" " " A to 6th station $= 13\ a$.
" " " A to 7th station $= 18.2\ a$.
" " " A to 8th station $= 24.8\ a$.
" " " A to 9th station $= 33\ a$.
" " " A to 10th station $= 48\ a$.

From the above we see that for a length of spiral 100 ft. and divided into 10 stations the total deflection angles of the 10 stations of spiral are given by multiplying the constants 1, 2.2, 3.8, 6, 9, 13, 18.2, 24.8, 33, and 43, by the deflection angle per foot of the original circular curve.

The constant distance back of the point of tangent of original circular curve at which the spiral is to commence is obtained from formula (VII.) which becomes

$$l' = \frac{100}{10}\left\{1 + \tfrac{1}{3}\left(\frac{100-1}{10}\right)\right\}$$

$$\text{(XII.)}\quad \therefore l' = 43 \text{ ft.}$$

And the required distance

$$l - l' = 100 - 43.$$

$$\text{(XIII.)}\quad = 57 \text{ ft.}$$

Let us now take an example with our adopted spiral.

Suppose two tangents to have an angle of intersection of 40° and that a 4° curve with 100 ft. spirals is to be located between them.

If the P. C. of this 4° curve, without spirals, was to have been at station 20+57, the P. T. of same curve without spirals would be at station 30+57.

To run in this 4° curve with the spirals, we have to commence the first spiral at a point on the tangent 57 ft. back of the original P. C., or at station 20. The end of the first spiral will of course be at station 21. The value of a for a 40° curve is 2.4 minutes per foot, hence deflection angle of spiral is (43) (2.4) minutes $= 1°\ 43'$, and as there are to be 2 spirals the deflection angle of the circular curve to be run in between the two spirals will be $(40° - 3°\ 26') = 36°\ 24' = 2{,}184$ minutes.

The length of the circular curve to be run in between the two spirals is $\frac{2{,}184}{2.4} = 914$ ft.

As the end of the first spiral or beginning of circular curve is to be at station 21, the end of the circular curve or beginning of second spiral will be at station 30 + 14, and end of second spiral will of course be at station 31 + 14.

Set up the transit at station 20, and for each 10 ft. station of first spiral deflect from the tangent half the angles given, by substituting in set of equations (XI.) 2.4 minutes for a; these angles are 1 minute, 2½ minutes, 4½ minutes, 7 minutes, 11 minutes, 15½ minutes, 22 minutes, 29½ minutes, 39½ minutes and 51½ minutes.

Having laid out the end of the first spiral, which falls on station 21, by deflecting from the tangent 51½ minutes as above, set up the transit at station 21, take a back sight on station 20 with 51½ minutes on the other vernier, turn vernier to zero, when the line of collimation will be a tangent both to spiral and circular curve to be laid out. Lay out circular curve from this tangent in the usual way, using 2.4 minutes deflection per foot until station 30 + 14 is reached, when from the tangent at this point lay out the second spiral, by deflecting the same angles used in laying out the first spiral.

Having reached the end of second spiral and having taken a back sight on the beginning of same spiral, it will be seen that the tangent is struck to a nicety. The difference between the radii of original circular curve, as run in between the two spirals, or the displacement of original circular curve, is given by formula (VIII.), which becomes in this case

$$R - R' = \frac{100}{10}\left\{1 + \tfrac{1}{3}\left\{\frac{100-1}{10}\right\}\right\} \sin. 51\tfrac{1}{2}'.$$

$$\therefore R - R' = 0.64 \text{ ft.}$$

It is readily seen that no practical error has been made in using a radius of 1,432.69 ft., instead of one of 1,432.05 ft., for the laying out of the circular curve between the two spirals.

The only objection to this method of setting out these easement curves is the short back sight, after laying out each spiral.

On this road 30 meter spirals are being laid out

by locating parties as well as for track centers, and the 30 meters back sight has been found to be of no inconvenience whatever, having laid out long tangents, with this back sight, with extreme accuracy. W. H. FRY.

NEW GEOLOGICAL DEVELOPMENTS.

FOSSIL STATION, Oregon Short Line Railway, Via Granger, Wyoming Territory, Feb. 20, 1882.

EDITOR ENGINEERING NEWS:

SIR: At the place we are now there are immense deposits of coal. The tunnel on the line passes through a vein 30 feet thick, and as yet but little is known by boring or shafts. The coal is now coking, but of a bright luster, and decrepitates on heat being applied or by exposure. This pass is 7,200 ft. above sea level, and is known as Hodges' Pass, after the first engineer who ran a line here. The range is the Wahsatch, and here are the most remarkable deposits of fish, oyster shells, cocoanuts, palm leaves and the mixed vegetation of different climates. No careful investigation has yet been made, and great discoveries may be made of remains of past seas. Fish are found here in the strata, perfect remains of different sizes, from 2 in. to 22 in. long. I would like you to have some of these specimens.

Yours truly, JAMES M. HAMILTON.

DANGERS OF SEWAGE AIR.

PHILADELPHIA, March 5, 1882.

EDITOR ENGINEERING NEWS:

On page 73 in your last issue, in referring to the sewage farm near Paris, in the midst of which a village has recently sprung up, you say: What significance is to be attached to this fact in an atmosphere reeking with foul odors?

As some of your readers may be misled by this question, as to true facts, I would like to state that the atmosphere in the village does not at all reek with foul odors. In fact, when driving over the fields themselves, strong odors are rarely noticed. A well managed sewage farm that has been properly laid out is not such a great nuisance as might be supposed. Only when carelessly managed or when sewage is stored in tanks does a farm become very offensive. The reason for the forming of a village was the enormous increase in the productiveness of the soil, since sewage is applied for irrigation, which fact has attracted a number of farmers.

Regarding the effect of sewage exhalations on health, there is yet much uncertainty. Two points, however, seem to be gaining acceptance: First—The injurious elements of sewage are either poisonous gases, which may act debilitating on the system, or they are specific germs, which, when entering the lungs or stomach, may produce a zymotic disease. Unless we happen to seize upon such germs in some way, or inhale sufficiently concentrated gases, no injury would be done. Secondly—There is hardly a doubt that both of these effects may be annulled, at least to a very great extent, by accommodation. The sick rate and death rate among the persons engaged in cleaning out sewers and managing sewage farms is, as far as I have been able to find out, below the average rate in cities. The most offensive duties are perhaps those of cleaning the screens in front of sewage pumps, which need constant attention on account of a possible sudden obstruction. The men engaged at this business at one of the London pumps told me that they considered the position a good one, and that there had been nearly one hundred applicants during a recent vacancy. One man had been there sixteen years, and had never been sick, save once with nausea and headache. He was robust-looking and in excellent health. The men work twelve-hour shifts, one week during the day, the other during the night. Their wages are 26 shillings or $6.50 per week. Yours truly,

RUDOLPH HERING.

BRIDGE STRESSES.

SPRINGFIELD, Mass., Feb. 25, 1882.

EDITOR ENGINEERING NEWS:

Probably many of your readers, who, like the writer, have had a good deal of intercourse with the old school of practical Howe truss bridge builders, have heard from some of them the opinion which I have found almost universal that the angle of the braces has a great effect on the lower chord strain. That is, you must use short panels (they say) and make your braces a good deal more than 45° toward the vertical, for if they are flatter they make more strain on bottom chord and pull it apart.

Of course every engineer who has looked into the matter at all knows that for a truss of given length, depth and load, the angle of the braces and number of panels has no effect on, and does not enter into the maximum center chord strain at all, which is what we provide for in a Howe bridge, and only locally affects the strain anywhere in the chord. For instance, take one truss with square panels and brace at 45°, and a similar one with double the number of pannels. The center maximum strain will of course be equal, and the strain at every panel of the first will be the same as at every other panel of the second. The only difference is that in the long panel the strain is uniform over the whole panel, and in the short panels it is composed of two increments, one of which is added in what would be the middle of the long panel.

Now, as I believe that no practice and theory of this kind grows up among practical men without *some* good reason, the subject being recalled to my attention lately, I looked into it a little and I believe the true reason for the difference in practice which they find between long and short panels is simply in the added *girder* strain. The floor system in a Howe bridge being distributed over the whole panel length of bottom chord by floor beams (instead of concentrated at panel points as is the general practice in iron), of course the girder strain in chord, additional to chord strain proper, increases in a much larger ratio than directly with length of panel, and it is just there that I think the "milk in the cocoanut" is secreted.

All this may be nothing but an old story to many of your readers, but being new to me I give it for what it is worth.

Another little point on which I should like the opinion of some of your professional readers:

In designing an iron bridge for a certain railroad, a riveted Warren girder, say 50 ft. long, 10 ft. panels, with supended oak floor beams 16 in. apart, the specifications required area for girder strain, besides net area for chord strain. The bottom chord was made of two 10½-in. channel bars, placed vertically, with vertical plates added for requisite area toward the center. Now, I figured it in this way. Provide in net area of channels and plates for the chord strain. Now the girder strain is compression above neutral axis of chord (which simply goes to counteract so much of the tensile chord strain) and tension below neutral axis, added to chord tension. Provide for this by riveting plate, say 4 × ½, horizontally under lower flange of channel of net area sufficient for girder tension.

The railroad company's engineer would not accept this; but required, first, channels sufficient to act as girders independently; then plates to meet total chord strain without reckoning channels at all. Of course he was within his right in requiring perfect safety for his company, if he had any doubts; but, as a professional question, if you were figuring down to the last pound of iron, am I right or wrong? Truly yours,

W. H. BURRALL, C. E.

THE STANDARD METRIC CHAIN.

BOSTON, March 7, 1882.

EDITOR ENGINEERING NEWS:

A description of the method of applying the metric system to the stationing of a railroad, or other similar work, will be an appropriate conclusion to the series of articles bearing the above title.

For the elementary purposes of engineering and land surveying it is customary to set stakes at every change in alignment and at every noticeable change in the surface of the ground. During the primitive days of the profession, before the wonderful development of the systems of canals and railways that has occurred during the past century, this was the prevailing method.

Each stake was marked with some designating letter or number, which was recorded in the note book in a column headed "stations," a term which at that time merely signified a point occupied for the purposes of the survey. In another column was recorded the distance from one station to another, which was measured with the Gunter chain of 66 ft. ($20\frac{13}{100}$ meters), an implement used in common by land surveyors and civil engineers in the early days of the profession. The distances between stations were entirely irregular and arbitrary, being determined solely by accidental topographical features.

One of the earliest improvements in engineering methods caused by the rapid extension of the railway systems of England and of this country was the introduction of the practice of placing the stations at short equidistant intervals, thereby greatly reducing the labor of the subsequent computations. The English engineers, with characteristic conservatism, contented themselves with setting their stakes at such equidistant intervals as are conveniently obtained by the Gunter chain, which they retained in their field work.

The American engineers, however, introduced the decimal method of dividing the foot, adopted it as their unit of measure, and increased the length of their chain to 100 feet ($30\frac{48}{100}$ meters).

This length was chosen, not on account of the intrinsic superiority of a measure of that absolute length, but because of the accidental feature that it comprises one hundred units when expressed in feet. Apart from this latter property, the measure is unwieldy and inconvenient.

The term "station" also gradually acquired a new signification, while still retaining its old meaning, being often used to indicate the *interval* between two stations, and, in particular, the interval given by a chain of 100 ft., which was used as the unit of stationing.

A station 100 ft. in length being only adapted to a comparatively *smooth* surface, shorter intervals are required in an undulating or rough country. On such ground, which forms the larger portion of the surface upon which engineering surveys are conducted, the stakes are often set at intervals of 50 or 25 ft., being numbered *fractionally* in terms of the station of 100 ft., and recorded in the same manner.

If, on the contrary, the length chosen for the unit of stationing had been one suitable for a *rough* surface, then the intervals between stakes on rough, undulating or smooth ground could all have been marked and recorded in *whole numbers*, or *multiples* of the unit of stationing, thus avoiding the use of fractional stations or sub-stations, except for the location of fixed objects, or in cross-sectioning excessively rough ground and simplifying the records and the marking of the stakes.

The metric system gives us a unit, the *dekameter*, well adapted for this purpose.

To obtain clear ideas upon this subject, let us, in imagination, supply ourselves with a *dekameter chain*, and run a straight line, of say five kilometers, over a diversified country, setting stakes at every *dekameter* end, numbering them consecutively from 1 to 500.

The initial point being marked zero, these numbers will indicate the distance to each stake in dekameters.

Upon inspecting this line of stakes we perceive that a survey based upon it will be of extreme accuracy, but will require a corresponding amount of labor.

We find the degree of accuracy is adapted to ground of a rough and rocky character. We will suppose the first kilometer of our line to be of this description, and aside from the introduction of a few stakes to reduce the interval to half a dekameter where the surface is exceedingly rough, no change is required on this part of the line.

The stakes on this section will therefore retain the original numbering.

After the first kilometer, we may assume that the character of the country changes, becoming undulating until it reaches some flat alluvial ground in a river valley.

Here we find that our survey will exceed the accuracy demanded, and we direct the axemen to remove every other stake, leaving only those marked with *even* numbers.

This increases the interval between the stations to 2 dekameters, and brings the amount of work required in this part of the survey within reasonable limits.

The stakes remaining upon this second section of the line are marked with the *even* numbers of the original series, as 122, 124, 126, etc.

Upon reaching the river valley, we find that the length of the station may be again increased without impairing the accuracy of the survey; and we again direct the axemen to remove every other stake, increasing the interval to 4 dekameters. The stakes on this third section will be marked with every *fourth* number, as 320, 324, 328, etc.

A review of our experimental line, as it is now staked, shows that a survey can be conducted more rapidly by means of a *double dekameter* chain than by means of the dekameter which we have used, and which proves to be adapted only to the rougher portion of the line.

We have here another illustration of the adaptability of the metric system to different kinds of work. Stations are provided for the various surfaces met with, suitable to the character of each. The numbering of the stakes and the record of the stations can be kept in whole numbers, with very few exceptions. The distance between consecutive stakes, or between distant stakes, may be had in dekameters by a single subtraction, and may be had in any other metric unit by suitably changing the decimal point. Upon preliminary surveys greater distances may be used between the stakes without losing any of these valuable features. CHARLES H. SWAN, C. E.,

Chairman Committee on Manufactures American Metric Bureau.

NEW IDEAS IN BUILDING.

Several novel features in building have just been introduced in an eight-story business house being erected in New York by Mr. Vernon K. Stephenson. The tide of opinion in the fire department and among insurance companies having lately turned against iron beams, the owner has placed on his floors thick wooden beams one foot from centre to centre and filled the interstices with cement, thus forming a solid floor two feet in thickness, which he claims will resist the penetration of fire for several days, whereas, he says, "the iron beams would bend with the heat and fall out and the building cave in." The stairs are of slate; the walls three feet in thickness.—*American Manufacturer.*

ENGINEERING NEWS.

GEO. H. FROST.....PROPRIETOR.

Tribune Building, New York City.

JULIUS W. ADAMS, *Past President A. S. C. E.*, EDITOR.

S. D. V. BURR.....ASSOCIATE EDITOR.

SATURDAY, MARCH 11, 1882.

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Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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NOTICES OF MEETINGS.

THE AMERICAN WATER-WORKS ASSOCIATION.—The second annual meeting of the American Water-Works Association will be held in the City Hall, Columbus, O., on Tuesday, March 14, 1882. J. H. DECKER, Secretary.

"RULE OF THUMB" ENGINEERING.

"I am not a scientific engineer but a practical one; for sixteen years I have been engaged in railroading and mining; in California I built about one hundred and thirty miles of railroad; although I have been in caissons before, yet the tunnel work was my first experience with compressed air. I know nothing of mathematics; in my experience I have grasped such matters as a whole. I believe that the study of mathematics in that kind of work has a tendency to dwarf the mind rather than enlighten it; perhaps all my life I have been going contrary to the advice of engineers. They don't as a rule study anything practically, and all the theories they study and advance are upset in practice. I never saw any two engineers yet who would agree on any point. Mr. Brush had a theory, and as I had often found theory at fault, I paid no attention to it, but devoted myself entirely to practical work. I shall go on with the work until it either falls through entirely or it is opened to the public. This accident may teach the men in the future to be more cautious, and, therefore, in the future there will be fewer chances of a repetition of this experience.

If I were building a railroad (or tunnel) of which there were a dozen directors, I think I should take the biggest fool of the dozen and let him follow his plan." *D. C. Haskin, President and Chief Engineer (?) Hudson River Tunnel, before the Coroner's Jury, Sept. 29, 1880.*

One of the greatest engineering works of the present time is the tunnel which is being driven under the Hudson River, in front of this city, for the purpose of bringing the railway traffic, now terminating in Jersey City, into the business center of New York. After years of litigation in the courts, the tunnel construction was finally commenced about two years ago, with Mr. D. C. Haskin (whose autobiography is given above) as the leading spirit. Compressed air and an unconcealed contempt for civil engineers and their methods are Mr. Haskin's hobbies. He did for a while employ a civil engineer *by the hour* to give lines, grades, etc., but to the theories or advice of this employé he "paid no attention." One day Mr. Haskin's tunnel caved in and drowned a lot of poor fellows—an unlucky incident in the history of the tunnel, but one which was of use, inasmuch as it would "teach the men in the future to be more cautious." Jersey justice said "nobody was to blame," and after digging out the dead men and débris and spending the yearly salaries of several first-class engineers in repairing damages, the big bore was once more started, with the former small engineering force still further reduced in numbers. A change, however, apparently came over the dream of the management as it became expedient to float tunnel stock, presumably, for it was duly announced in the daily and class journals that a well-known civil engineer, a member of the American Society, then in Europe, and an expert in the use of compressed air in making deep foundations and in the construction of difficult engineering work, had been engaged to take charge of the tunnel as Chief Engineer. Under that management, with able assistants, the tunnel has been constructed for a year past, until recently it was announced in a daily journal that this Chief Engineer had resigned, which we have good reason to believe is a fact, and it is an open secret that it was because he very properly would not be figure-head only to shoulder the possible consequences of the Haskin style of engineering. If we mistake not, there is now an opportunity to buy some Hudson River Tunnel stock; before any simple-minded and trusting investor exchanges his greenbacks for such he would do well to take a stroll to the New York caisson and study the possibilities of the present method of opening that end of the tunnel; then go over to New Jersey and passing through the scene of the "recent unpleasantness" at that end, and being "locked" through to the present field of operations, let him but use his eyes and common sense in his investigation of "practical" engineering. Our reporter has given elsewhere a description of what he saw; he has not told half the story of what he saw and heard, and his diagram but imperfectly illustrates the condition of affairs in the big hole now being excavated through the river mud. Imagine a section of the roof of a great tunnel in such "silt" or soft mud as came pouring down on the doomed fellows that were caged in there over a year ago, actually built as shown by the diagram, with one end down about 18 in., a large crevice at lower end stopped up for the time being with pieces of boards to prevent the mud from coming in; if any accident happens to the air-compressing apparatus, who can tell what would be the consequences, especially as there is only *one* air-lock provided for egress, although the engineers have protested against such parsimony, and have not only protested but *put it on record*, so that they shall not be held accountable in case of future mishaps. As a journal of civil engineering, and believing in the ability of American civil engineers to take hold of such an undertaking as the Hudson River Tunnel, and with the least possible expense carrying it through to successful completion, and in view of the inevitable odium that would, for a time, be brought against the profession in case of its failure, even though civil engineers were not responsible for such, and in view of the dangers to life and the exposure to painful disease, under the present conditions of the Hudson River Tunnel, we enter our protest to its present engineering management and we wish to declare an opinion now that money is being wasted and human life is unnecessarily exposed by the present method of construction, and we furthermore believe that under the present method it will never be completed.

WATER SUPPLY FROM LAKE GEORGE.

A bill was introduced by Senator Nelson in the N. Y. Legislature Feb. 4, authorizing the construction of the New York and Hudson Valley Aqueduct, from the Upper Hudson to the City of New York, with a capital of $50,000,000; and the paper from which we take the notice, after explaining the object of the bill, to be "the supplying New York City and the other cities of the Hudson River Valley with pure water from Lake George," adds, "That the project seems too utterly visionary for practical men to treat it with patience, and there is little doubt that it can be turned into a piece of very discreditable and damaging jobbery; and this scheme will bear watching."

Without reference to any political complexion which it may assume in any case, we surely are justified in remarking that it may be a question what bill before the Legislature of this State may not be used for jobbery? And we can scarcely imagine a bill drawn to promote any interest (and no bill would be likely to be drawn devoid of interest to some one or more) that, in its progress through the two houses of the Legislature, will not only bear, but absolutely require, watching, and that pretty severely, as times are, and we did not suppose that any member of the press of this State, or indeed of any other State, should regard it as a sine qua non that, as an antecedent to the passage of any bill through the Legislature, the abstract merits of the bill should be so apparent that all who read may understand them. It will be an era of which few of us will see the advent when this principle is a recognized one in New York legislation, and, therefore, we are not altogether surprised that the journal to which we are indebted for the notice should be slow to believe that what it did not at a glance perceive the genuineness of, had a covert meaning, in accordance with its own experience. What use may be made of the introduction of such a bill as the one above mentioned by the manipulators of the various political deals which are so rife just now, it is impossible for us to say, but we do know that the inception of the project had no political significance whatever, and no pecuniary one beyond the fact that the want of pure water in the cities on the Hudson River, including the city of New York, would render a scheme for supplying them all from a single source, if feasible within reasonable limits of cost, sufficiently remunerative.

We know nothing whatever of the personnel of this Hudson Valley Aqueduct Company—know nothing of its organization, but are acquainted with the engineer who was selected to make the examinations, surveys and estimates, the results of which we presume were sufficiently satisfactory to justify the formation of the company and their application to the Legislature for the powers requisite to the realization of the project,

The engineer is a hydraulician of more than average standing in his profession, having more than a merely local reputation, and known by name, at least, to most of his profession throughout the country. In an interview with him a month or two since, while the work of examination was in progress, and before any steps had been taken to secure the aid of the Legislature, the features of the proposed work were explained to us in general, with sufficient detail as to justify us in the belief of its entire practicability, and at a cost by no means disproportioned to the benefits to be anticipated.

The project in brief is as follows:

A dam is to be constructed over the Hudson River above Glens' Falls, say 70 ft. in height, and where the flow line will be circumscribed within comparatively narrow limits by the precipitous character of the shore line of the river. The reservoir created by this dam is to be connected by canal with a canal from Lake George, the latter by a tunnel through the dividing ridge. This will render Lake George a storage reservoir for the waters of the upper Hudson and Schroon rivers, draining some 3,000 square miles of the Adirondack region, and, by an open canal, taking favorable ground on the east of the Hudson River, convey some seven or eight hundred millions of gallons of water daily down the valley, to be distributed to the various cities on its banks as may be desired, leaving a surplus of several hundred millions of gallons daily for the city of New York. The country offers no impediment to modern engineering enterprise. The grade is favorable and the valleys admit of crossing by a system of iron pipes, the extent of which will depend upon the demand for water. The supply of water is of undoubted purity, without any possibility of contamination in its source for generations to come, if ever, and the supply unfailing to the extent named.

The precise length will depend upon whether the scheme embraces a supply direct to the city, with sufficient head for its distribution, or whether the termination would be in the present Croton Lake, thus increasing the quantity of water only, and indirectly the head in the lower part of the city by an independent supply direct to that locality. Neither the working head in the city nor the distance to Lake George as determined by the survey can we give with precision, but understand that to deliver 700,000,000 gallons into the city daily, or its equivalent, can be effected at an estimated cost of between thirty-five and forty millions of dollars, the distance being a little over 200 miles. Of course this means that, as this city will not require over 300,000,000 gallons at the maximum, the remaining 400,000,000 can be used at intermediate points in the valley.

As before stated, there is nothing so "utterly visionary in the scheme as to forbid its being entertained by practical men." Nor is the estimated cost disproportionate to the end in view. If it be decided to deliver the water into Croton Lake, the cheapest project, a new aqueduct will still be required from the city to the lake. If, on the contrary, the design be to deliver the water into the city with a working head of 200 ft. for extension of manufactures, as we are assured the levels will permit, there will, in that event, be no further need of a new aqueduct, and the city has nothing to spend, as the enterprise contemplates the construction of the work by private means. Whether the present pipe distribution will stand this increased pressure, we are not at present prepared to say, and how far with the present temper of the Legislature, in reference to the government of the city, this project may be used to antagonize that of the proposed new aqueduct and reservoir below the Croton Lake, it is impossible for any one to anticipate. That the promoters of this scheme had in view originally, and in good faith solely, the idea of providing a plentiful supply of pure water, with an increased head for manufacturing purposes, and at private cost, we have no doubt whatever, and it remains to be seen, after the details of the project become better known, how far it can be

made a factor in the struggle of opposing political factions for the government of the city. That it will, if it possesses any inherent strength, be used for this purpose, all experience points as inevitable.

EAST RIVER BRIDGE.

A meeting of the Board of Trustees of this work took place on the 6th inst., and some important business was transacted. The method of the future traffic of the bridge known as the circulating system was adopted. This method consists in the operation of an endless rope in constant motion, driven by a steam engine located under the Brookly approach. The passenger cars are provided with a means for seizing this rope, and the speed of the cars becomes the speed of the rope. At the termini the cars are switched to the opposite track, and to obviate the difficulty of switching across the roadways of the bridge, the termini of the car tracks become gradually elevated on a higher platform than that of the ordinary traffic at each end, and by which, if need be, connection can be made with the elevated railroads. The speed of the passenger cars will be about 10 miles per hour, and it is estimated that 7,000 passengers can be transported each way in an hour. The time is again fixed for the opening of the bridge for traffic on the 31st day of March, 1883. This date is so alarmingly near to the first of April that the public will be very likely to consider the announcement as partaking faintly of the character of some of the previous ones—that is to say—a joke. And when they learn that the amount of money called for in order to this consummation is $1,250,000 in addition to what has already been expended, they may be slow to perceive precisely where the joke comes in. It is confidently asserted, however, that this will be the last call. We append the statement of the Chief Engineer as to the anticipated disposal of this amount, and which the Legislature will be called upon to authorize.

Statement of the amount of money required for the completion of the bridge, February, 1882:

I.—Estimated cost of completing the bridge and approaches, as follows: Liabilities on outstanding contracts for material	$565,322.32
Estimated cost of material required for the completion of the bridge and approaches, other than that contracted for	114,670.60
Salaries of officers and engineers, and cost of labor	117,632.97
Total	$797,625.89
Cash on hand Feb. 1, 1882, and due from the cities, less liabilities for salaries and material received in January	$553,557.39
Amount required for completion of the bridge and approaches in addition to the money on hand and due	244,068.50
II.—Estimated cost of elevated tracks and platforms at the termini, cost of elevated platforms, including track arrangements, ropes, waiting rooms, ticket offices, etc	268,808.00
Cost of machinery, boilers, hauling ropes, etc	37,978.00
Boiler house	12,000.00
Rolling stock	132,000.00
Total	$450,886.00
Ten per cent. for contingencies	45,088.60
Total	$495,974.60
Added by Transit Committee	100,000.00
Total estimated cost of elevated tracks and platforms	$595,974.60
III.—Estimated cost of fitting up warehouses under the arches of the New York approach, complete for occupancy	348,184.00
IV.—Price of land in Chatham street, New York, adjoining bridge property, and agreed to be purchased by the trustees	17,500.00
Total	$1,205,727.10
Add for contingent expenses	44,272.90
Grand total	$1,250,000.00

W. A. ROEBLING, Chief Engineer.

The treasurer's report showed that up to the 1st of March the total receipts had been $13,543,947.19, and the total expenditures $13,496,393.74.

TEHUANTEPEC SHIP RAILWAY.

We note from a daily journal of the 4th inst. a communication from Washington that the Committee of the Senate had reported favorably on the Ship Railway bill known as the Eads Ship Railway, and with some slight amendments recommended its passage. It seems that during the third session of the Forty-sixth Congress a special committee of the House of Representatives reported in favor of this Isthmean Ship Railway.

The opposition to this scheme, so far as we can judge, has arisen mainly from the friends of what may be regarded as rival projects. We do not recall the testimony of a single professional man, possessing the qualifications which would entitle his opinion to any weight, which was not influenced more or less by preconceived opinions in favor of some other interoceanic connection which would presumably suffer by the rivalry. We have already expressed our opinions at length in reference to the proper location of an interoceanic isthmean transit for ships, and used the expression "that if nature had provided a strait at the Isthmus of Darien, still, the needs of a coasting commerce would call for a communication being opened between the Gulf of Mexico and the Pacific coast in the interest of American commerce and not dominated by foreign guns."

It is well known that if a vessel leaving the mouth of the Mississippi River, bound for California or the East, crosses the isthmus at Tehuantepec, her voyage will be 1,230 miles shorter than if she crossed at Panama. If a vessel leaving New York bound for the same destination, crosses the Isthmus of Tehuantepec, her voyage will be 750 miles shorter than by way of Nicaragua, and 1,250 miles shorter than by the way of Panama. As this large saving in distance chiefly affects the commerce of this country and Mexico, and not the commerce of Europe, it must be apparent that the location of a ship transit across the isthmus is of vital interest to the United States.

That the project of Captain Eads is entirely feasible, the array of disinterested professional talent enlisted in its support should be perfectly convincing, and its location commends itself with peculiar force to all with whom the American feeling is paramount to any consideration of a mere private nature. The main features of the Senate bill are as follows: A guarantee by the United States of a dividend of 6 per cent. per annum for 15 years on $50,000,000 of the capital stock of this company, the capital stock being $75,000,000, and stipulates that the company shall transport, gratis, for 99 years, the mails, war vessels, and all other property of the United States, and shall transport American merchant vessels for one-half the rates charged by the company on all the commerce except that of Mexico. It is further provided that for any advances made by our government under its guarantee the company is to give its bonds, payable in 15 years, without interest, which bonds, in the event of their non-payment at maturity, are to be receivable for tolls on any American vessel, with 10 per cent. added to their face value. The guarantee is to attach to the extent of $5,000,000 when 10 miles of the ship railway and the terminal works connected therewith shall have been completed and tested in the presence of government engineers by the safe transportation of a loaded ship weighing 2,500 tons from the harbor to the terminus of the said 10-mile section and back again, at an average speed of six miles per hour. Another $5,000,000 is to be guaranteed when another 10-mile section, with the necessary terminal works, shall have been completed and tested at the other end of the railway. A commission of engineers, appointed by the President, is then to examine the intermediate portion of the route, and report whether or not the completion of the ship railway over it is practicable at a cost not exceeding $60,000,000. If the commission reports in the affirmative, the government guarantee is to attach (for the remaining $40,000,000 of the $50,000,000 of stock to be guaranteed) in accordance with the successive completion of the intermediate sections of the line. If the commission, however, reports in the negative, the bill provides that no further guarantee shall attach until a loaded ship weighing 4,000 tons shall have been safely transported over the entire line from ocean to ocean. The bill also provides that in determining the amount for which the government shall be liable under the guarantee, one-half of the gross revenues of the company shall be considered as net profit.

PERSONAL.

MR. S. B. REED, superintendent of construction of the Canada Pacific, has been appointed chief engineer in place of Gen. Rosser, resigned.

CHIEF ENGINEER JOHN H. LONG, of the United States Navy, died on Thursday, the 2d, at his residence in Astoria, aged 55 years. He was a native of England, and came to this country while a boy and was apprenticed to R. Hoe & Co., machinists. He entered the navy as third assistant engineer. Having resigned his position he began the manufacture of machinery. When the Rebellion broke out he again entered the navy as first assistant engineer. He became chief engineer and served throughout the war. He was with Farragut in Mobile Bay, at the capture of New Orleans, and on the Mississippi, where, from exposure, he contracted the disease of which he died. He was the author of a book on mechanical engineering, and was generally employed by the Government upon special duty in that branch.

ENGINEERS' SOCIETIES.

LIVERPOOL ENGINEERING SOCIETY, ROYAL INSTITUTION, COLQUITT STREET.

At a meeting of the above society held on Wednesday evening, Feb. 15, 1882, Mr. Frank B. Salmon, President, in the chair, the adjourned discussion on Mr. W. Goldstraw's paper on "Municipal Control of Streets and Buildings," read at a previous meeting, took place.

The writer of the paper, in starting the discussion, said the chief point was the necessity for a general Building Act. This necessity arose from the great number of different statutes and bye-laws. Mr. Boult had put the number at 2,000; but, considering that many towns had several sets of regulations on the subject, the number was probably nearer 3,000. Manchester was worse off than Liverpool, as the local building regulations were not so efficient. A general Act would improve the state of things in each town, and induce uniformity throughout the country. If such a measure is expedient, what are the points with which it ought to deal? The following seem to be essential:

1. Levels, width and surface conformation of new streets.
2. The materials of walls and roofs of new buildings,
3. The thickness of walls of new buildings.
4. The separation of buildings by party walls.
5. The construction of chimneys and flues.
6. The provision of open spaces in connection with dwelling-houses.
7. The dimensions of rooms and windows of dwelling-houses.
8. Projections beyond the regular line of buildings.
9. Ruinous or dangerous buildings.

There are other subjects hardly less important, which it is very desirable to treat in the general Act suggested. For example:

1. Direction and position of streets.
2. Coal-shoots, vaults and areas in streets.
3. Foundations of domestic buildings.
4. Damp-proof courses in houses.
5. Limits of height of houses.
6. Means of egress from large domestic and public buildings, including hotels.
7. Warehouses for combustible goods.
8. Strength of timbers in floors and roofs.

As it is impossible to carry out regulations unless they are precise, there must be details, clearly and positively stated. Very little should be left to the discretion of the Surveyor. In some matters, however, where rules cannot be laid down, the Surveyor must be a judge. Dangerous buildings form an example of this class of cases.

As to the question whether public building surveyors should be allowed private practice, there appeared to be, outside the metropolis, a general opinion against such a course.

On the whole, the following were fair questions for discussion:

1. Is a general Building Act wanted?
2. If so, what should be its main provisions?
3. Should those provisions be expressed in general terms, or in detail?
4. Should the building surveyors devote their whole time to the public service?

Mr. Aldridge, President of the Liverpool Architectural Society, and several members of this Society, took part in the discussion, which was of a very interesting character.

A vote of thanks to Mr. Goldstraw for his attendance and information in reply to the discussion was carried unanimously.

The Vice-President announced that the next meeting of the Society would be held on Wednesday evening, March 1, when a paper by Mr. W. E. Mills, on the "Ventilation of Dwelling-houses and Public Buildings," would be read.

FRENCH ARCHITECTS' FEES.

An important decision has lately been delivered by the Third Chamber of the Civil Tribunal of the Seine, which determines the much-disputed point, whether the fee or honorarium of an architect should be reckoned on the limit price fixed before competition or on the amount of tender accepted. M. Bourdeix, architect, had been commissioned to prepare the plans of a house for M. Jacobi. Various contractors submitted tenders more or less below the limit price, the reduction in one case amounting to over 35 per cent. As a rule, in France, the construction of a building is not undertaken by one, but by several contractors, each taking his own particular branch, such as masonry, carpenter's work, plumbing, etc. When the time for payment came, M. Bourdeix, to whom all accounts were submitted, settled with the contractors at the price of their tenders, but claimed from M. Jacobi 5 per cent. on the original limit price (*devis*). This claim was contested. The owner paid into court 5 per cent. upon the sums actually disbursed. The Tribunal, however, decided that M. Bourdeix was entitled to percentage on the full *devis*, basing its judgment on the ground that all the contractors, having tendered considerably below the limit, more care and supervision were necessary on the part of the architect to insure good quality in the work. This decision will no doubt be accepted as regulating fees, and will make a considerable difference in the incomes of many French architects.—*London Architect.*

HIGHWAY BRIDGES.

BY ALBERT F. HILL, C. E.

The rapid growth of population in the United States, consequent upon the opening up of the rich lands of the West, is steadily increasing the demand for facilities of local inter-communication. Among these the highway bridge stands foremost in importance, and the great number of this class of structures which are annually erected makes it imperative that the standard of requirements for their construction should be brought up to the level of other important public works.

Highway bridges afford exceptional opportunities for the display of correct taste and engineering ability—it is therefor to be regretted that the country should be dotted all over as it were with bridges that must be classed among the "lost opportunities." Architectural monstrosities of this kind are to be found in all our large cities, and the rural districts abound in absurdly designed, wretchedly constructed and hideously painted bridges. Cities and city parks contain many examples of bridges, the construction of which though faultless and showing great engineering skill and fine workmanship, are nevertheless from the very excuse for their existence, viz., to construct a decoration for nature, absurd-looking.

The reasons for this state of affairs are manifold. The principal one, though, is probably to be found in the fact that in most instances the men upon whom the letting and the award of work for highway bridges devolves have duties imposed upon them for which their early training has not prepared them. In this may also be found the reason for their frequently selecting engineers, who have neither experience nor education, solely because their services—such as they are—can be obtained cheaply, quite oblivious of the fact that such men can and will throw away money and insure to them wretchedly constructed work. On the other hand, it must be admitted that neither bridge committees nor their engineers are perhaps as much to blame for this as the deplorable lack of proper legislation bearing upon the construction of public works. The committees' hands are tied in most cases, not so much by want of funds as by want of authority to use funds for the employment of experts. And thus it often happens that able and efficient county surveyors find themselves charged with duties in the supervision of iron construction for which they are utterly unfit. There is nothing derogatory to them in this. The vast field covered by engineering science compels our best talent to become specialists, as is the case in any other profession.

Bridge-construction is a specialty; and unless adopted as such an engineer will probably find it exceedingly difficult to keep up with the rapid and magnificent strides of this noble art, aside from the impossibility of becoming a competent judge of material and workmanship without long and patient "shop-practice." It may, therefore, be readily imagined how easily both committees and engineers become the prey of some third-rate—or possibly no rate—concern, who offers them the "lowest bids," and of course also the poorest work.

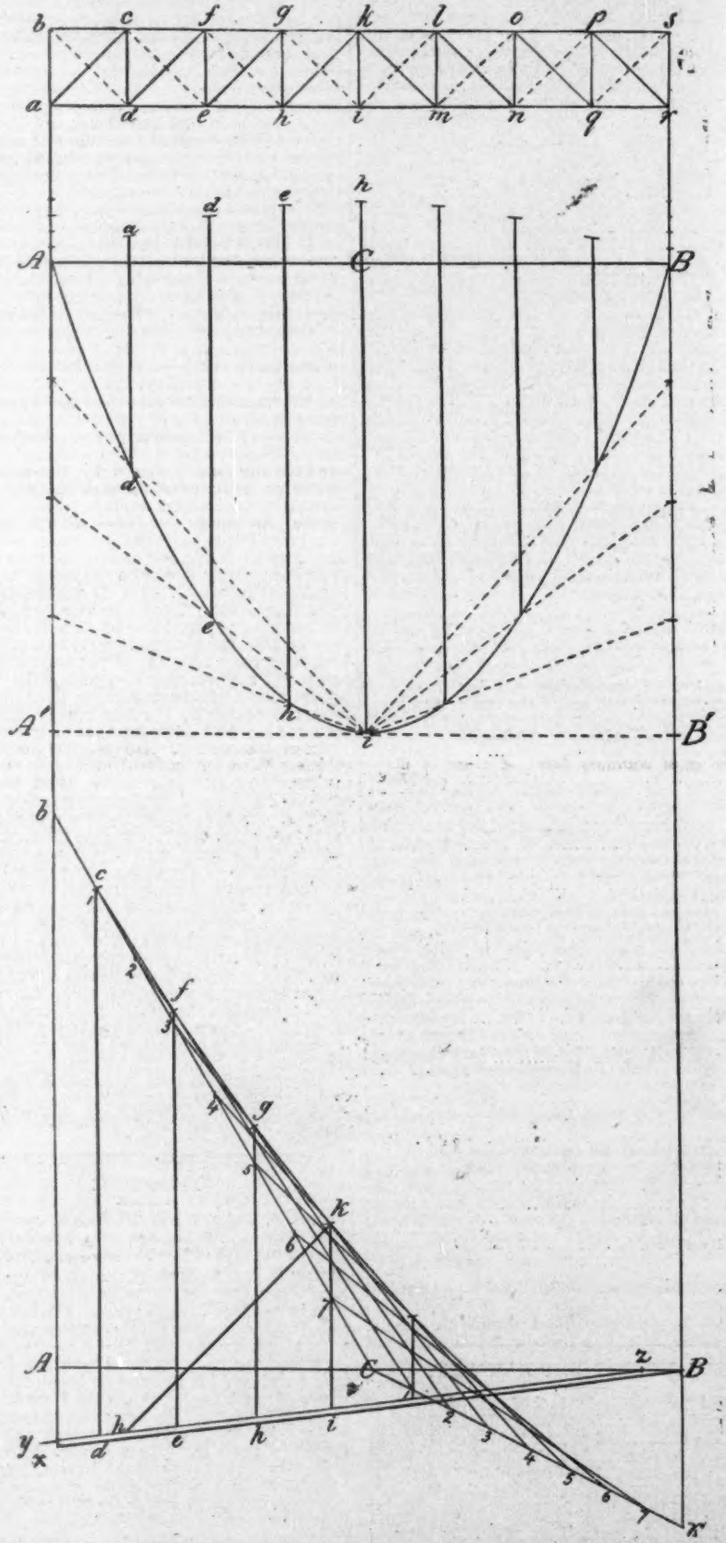
Attention has thus far been called to the characteristic defects to be found in highway bridges, and from these it is evident that what is chiefly wanted is a wider dissemination of knowledge of of the structural qualities of the materials which enter into their construction, as well as of the rudimentary elements of construction in general.

In regard to wood and wooden bridges very little need be said here. Knowledge of what good timber is, and good judgment of carpenter's work, is pretty general. If, therefore, a wooden bridge is properly designed and dimensioned by a competent engineer, there is no doubt that both material and workmanship can be safely entrusted to the supervision and inspection of "the neighborhood." That so many of our wooden bridges are short-lived and almost under constant repair is not the fault of the material or workmanship so much as of bad design. To this latter cause must be assigned the foundation for the testimony given by several county engineers in the West a few years ago, that the average life of a wooden bridge was not more than from 8 to 12 years.

This is singular evidence, considering that in this country we can point to such bridges as the Mohawk bridge at Schenectady, the Upper and Lower Schuylkill bridges at Philadelphia, the Delaware bridge at Trenton, etc., etc., etc.

The average life of all these bridges is over 50 years. But then they were designed by eminent engineers—were models of their kind of construction, and not merely the botchwork of a country carpenter.

The age of wooden bridges is rapidly drawing to a close, however, in the well-settled parts of this country, and iron structures are taking their places. And since the cost of a bridge *per lineal foot of length* increases with the length of the span, and iron bridges are so much more expensive than wooden ones, it may be proper right here to warn those in whose charge new structures may come against reverting into one of the earliest errors in bridge-building, viz., short spans. Every pier is an additional channel-obstruction, and in our often rapidly rising rivers and streams this becomes a matter for serious consideration. *Deep* foundations for abutments and piers and *long spans* are the best guarantee for the maintenance of communication and the safety of the bridge.



If but little *need* be said on the subject of wood in an article like the present, but little *can* be said on the subject of iron, beyond calling attention to and impressing upon the mind of laymen the fact that iron is a material of infinite variety of qualities, and of all construction materials the one most susceptible to treatment; that to judge correctly of its mechanical qualities from external appearances, fractures, etc., etc., requires long practice and thorough familiarity with the different processes of its manufacture.

Of all tests to which *wrought iron* can be submitted, the simplest and the one most easily applied is *cold bending*. While it furnishes no indication of the absolute strength or relative uniformity of the material, it is the best criterion of the two most important requisites—*toughness* and *ductility*. This test is made by simply bending a round or square bar, and by blows from a sledge hammer—say over the edge of an anvil—until the two ends are parallel to each other and about the thickness of the tested bar apart. If no cracks are visible at the back of the bend, after this test, the iron may be set down as of excellent quality for bridge purposes.

Another good test readily applied is to *nick* the bar first, and then subject it to cold bending by

moderate blows. If by this process the bar develops fine fiber of silky appearance, without showing any crystal-like spots, it is of good quality of iron; if it shows such spots or snaps off short during the process of bending, it ought not to be allowed in a structure.

If a reliable testing machine is available for the purpose good bar iron ought to show on an average about 50,000 lbs. per sq. in. of ultimate tensile strength, with an elongation of not less than 1½ in. per foot, and show a well drawn out and reduced area of fracture. Angle and plate iron is usually from 10 to 15 per cent. weaker than bar-iron, and, therefore, a corresponding increase of metal ought to be demanded in their use.

Cast-iron is so unreliable a material that its use in bridge construction ought not to be tolerated, except for bearing blocks, washers and post caps; in short, in small pieces only and under compression exclusively. Good castings ought to have a smooth and close-grained surface, and when broken should show a grayish, fine-grained fracture and be free from sand and blow-holes.

Of equal importance with the quality of the material is the proper dimensioning of the parts of a bridge in accordance with the strains to which they are liable to be subjected. This of course is a matter of calculation exclusively, and entirely apart from the skill requisite for appropriately *designing* a bridge. And right here let it be remembered "there is no royal road" either to results or to success in bridge building. Innate love for the work, faithful study and downright honest hard work must all be combined, and are the *sine qua non* of tangible results. At the same time there is in the minds of many a good deal of fancied mystery surrounding the making of a strain-sheet. Now if a plain, simple and quick method of getting at the salient stresses in a structure were placed at the disposal of those, who, not being bridge engineers proper, have yet to decide upon the efficacy and correctness of bridge plans submitted for their acceptance, this might be of some service to many.

Presupposing a knowledge of the rudimentary principles of algebra and mechanics, of the fact that all forms of trussing are referable to the principles of the lever, etc.; in short, presupposing that amount of knowledge with which any elementary treatise will make the reader familiar—we may at once proceed with the work before us, viz., to find *graphically* the stresses of a given truss.

The most common form of truss in highway bridges, is that with parallel chords. We will therefore suppose a truss of the general form, *abc....rs*, to have been submitted for acceptance.

Since the bending moment is greatest when the value of the shearing force is least, and *vice versa*, the chord strains must be considered separately from the web strains. All chord strains are horizontal strains, compression strains in the upper and tension strains in the lower chords, and become maxima when the truss is fully loaded throughout its whole length. Designating by w one-half of the live load per lineal foot of bridge—that on sidewalks included—and by w' one-half of the dead weight per lineal foot of bridge—floor system, etc., included—and by l the length of the span, then will $(w+w')\,l = W$ represent the maximum load per truss. Designating further by h the depth of the truss, then will $\frac{W\,l}{8\,h}$ express the maximum stress at the centers of the chords.

To represent this graphically assume any convenient scales for lineal and for strain measures—the larger the better, say 50 ft. to the inch for lineal, and 50,000 lbs. to the inch for strain-measure—draw AB by lineal measure equal to the length of the span ar, and Ci perpendicularly from the middle of AB and equal to $\frac{W\,l}{8\,h}$ by strain-measure. To find the chord strains for the different panels, drop a perpendicular from A and make AA' equal to Ci, and divide it into as many equal parts as there are panels in the half-truss *abki*. From *i* of the line Ci draw straight lines to the points of division thus obtained on AA', and where these straight lines are successively intersected by verticals corresponding to the panel-points *dehi* of the truss, we obtain points of the parabola—moment-curve—*Adehi . . . B*. Ci represents the amount of tension in *hi* and *im* and of compression in *gk* and *kl* of the truss, that portion of the vertical *eh*, which lies between the horizontal AB and the point *h* is the measure of the strains in *eh*, *mn* and *fg* and *lo* respectively; the part of *de* which lies between AB and the point *e*, is the measure of the strains in *de*, *ng* and *cf* and *op*. And finally, the same part of *ad* measures the strains in *ad*, *qr* and *le* and *ps* when the truss is fully loaded. To provide further against strains, such as loads concentrated upon short wheel bases might produce—fire engines, heavy safes on short trucks, etc—we must consider the excess of weight of such concentrated loads over the normal weight provided for already. Let wp represent the amount of live load provided against per panel, and x one-half of the concentrated load under consideration, then will $(x - wp) = W_1$ be the load we have still further to provide against. W_1 will produce the greatest effect when at the center of the truss, and this effect will be equal to

$$\frac{W_1\,l}{4\,h}.$$

Take this amount from the strain scale, and erect the vertical

$$Ch = \frac{W_1\,l}{4\,h},$$

lay the same off on the vertical AA' and above A, divide this space into the same number of parts as AA', and obtain the moment curve as before, but above the horizontal AB, and the verticals *ad*, *de*, *eh* and *hi* will represent the full chord stresses in their respective panels.

To obtain the strains in the posts, braces, diagonals or counters, in short the *web strains*, we must remember that the shearing force at any point in a truss is greatest when the longer part of the span into which this point divides the truss is fully loaded, and that therefore the shearing force is a minimum for $\frac{w'\,l}{2}$, *i. e.*, one-half the weight of the truss unloaded and becomes a maximum for $\frac{(w+w')\,l}{2}$, *i. e.*, one-half of the weight of the truss and the full load. We now proceed as follows, namely: Again draw AB parallel and equal to ar, make Ab equal $\frac{(w+w')\,l}{2}$ and Br equal $\frac{w'\,l}{2}$.

Connect the points *b* and *r* with C, and divide each bC and Cr into as many equal parts as there are panels in the truss (here eight) and number these divisions consecutively from left to right: 1, 2, 3 ....7; draw the lines 1—1....2—2....3—3....4—4 ....7—7, and the intersections of the consecutive lines, such as 1—1 with 2—2, 2—2 with 3—3, etc., will give points of the shearing curve at the middle of the corresponding panels, and the ordinates from AB to the points $c, f, g, k \ldots$ will be the measure of the shearing stresses in these panels. To provide now for the excess of shear caused by concentrated loads take the quantity $(x - wp) = W_1$ from the strain scale, plot the same at Ax and draw the line xB, and since the shearing strain is taken at the middle of the panel move the point B to *z* and draw *zy* parallel to Bx. The lines *ch*, *fe*, *gh*, *ki*,....will then give the full measure of the shearing stress in the corresponding panels, *cd* being the tension in tie or compression in the post *cd*,—*fe*, the tension in the tie or compression in the post *fe*, and so on according to whether we have vertical ties and diagonal braces in the truss, or vertical posts and diagonal ties. To find the measure of the strain in the diagonals, be they braces or ties, draw lines like *Kh* parallel to the diagonals, in the direction of their service, from the points *k*, *g*, *f*, *e*, and their lengths limited by the line *xy* will be the measure of the strain in them. The last point of the curve which lies *above* the horizontal and to the right of C limits the distance for which counters are required; in the diagram this is indicated by the vertical from the point 1 to the right of C.

Having thus ascertained the salient strains of a given truss—and the scope of an article like the present precludes the working out of details, etc., etc.—the next step will be the comparison of the dimensions of the parts as stated in the bid, with the strains thus obtained. Attention can be called here only to the most important facts. Remember always that different parts of a structure have different service to perform, some heavier some lighter service. To adhere rigidly to the rule that "iron shall not be strained more than five tons in tension and four tons in compression per square inch of effective section," is not only not wise, but rather otherwise, for in some parts more strain may be safely allowed and in others not nearly as much ought to be admitted. The following proportions will probably be found to agree with the best practice: For parts under tension allow, in bottom chords and main diagonals, 10,000 lbs.; in counters and long ties not more than 8,000 lbs.; in laterals, 12,000 lbs. per square inch of *effective* section.

Compression members, be they top chords or posts, should invariably be dimensioned according to either Gordon's or Rankine's formula—the latter being by far the preferable one, as giving results in better accordance with those obtained from tests. In floor-beams which are subject to transverse strains not more than 7,000 lbs. per square inch of *total* sections ought to be allowed if they are riveted girders, and not more than 9,000 lbs. if rolled beams. The shearing stress allowable in rivets and bolts should not exceed 7,000 lbs. and the pressure upon the bearing surface of the projected semi-intrados be not more than 14,000 lbs.

As regards details and connections, the greatest need for care is in the pins. Pins are almost invariably made too small, their size guessed at, rather than calculated, for the pitiable reason that proper pin-calculations take almost as much time as the calculation of the rest of the truss. For flat bars the size of pins should not be less than diameter = .8 width of bar, and for square bars diameter = 1.75 the side of the square. Next to the pins the form of the head of eye-bars is of greatest importance. There should be at least one-half more metal *through* the head than in the body of the bar, and in front of the pin the same as in the bar. As regards riveting it should be borne in mind that the thinner the web the closer ought the rivets be set, and that machine riveting is always better than hand riveting. Of the two great systems of bridges, the American or pin-connected bridge will mostly be found preferable to the English system, or riveted truss. Economy of material, almost exact workmanship, rapidity of erection, and lesser cost for false-work are its chief recommendations. Considering that the quality of the *joint* is the most important criterion of the workmanship in a bridge, and remembering the influence cramped positions and weather must necessarily have upon a riveter, the machine-made bearing and connection will invariably be found to take precedence over the field-riveted work.

Last, but not least, comes the floor system. Lack of attention to this important part of the structure is not only the cause of great discomfort in the use of a bridge; but also often leads to ultimate failure and accident. A stiff floor-system is always a pretty sure indication of a well constructed bridge.

Insist upon full provision being made against concentrated wheel-loads, and wherever possible adopt the compound riveted girder, in preference to the trussed rolled beam, as a floor-beam.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

Continued from page 75.

CCXXVIII.—CONCORD, N. H.

Concord, New Hampshire, in lat. 43° 15′ N., long. 71° 30′ W., is on both sides of the Merrimack River, which is bordered by rich intervale lands, bounded on the east by pine plains and on the west by rocky hills.

Settled in 1725, it was incorporated as a city in 1853. Water-works were built by the city in 1872 under the superintendence of James A. Weston, C. E., taking the supply from Long Pond, or Penacook Lake, 3 miles from the city and from 37 to 152 ft. above it. The area of the pond is 350 acres and its water shed 3 square miles. An earth dam with a stone heart wall 2 ft. wide at top and 31½ ft. at bottom, 18 ft. high and 250 ft. long is built across the outlet of Forge Pond 2,000 ft. below the original outlet of Long Pond. An elliptical brick conduit, 24 by 30 in., extends 1,950 ft. into the lake and conveys the water to the supply main of wrought-iron and cement, 14 in. in diameter and 3½ miles long. Distribution is by 26½ miles of wrought-iron and cement pipe, with 107 fire hydrants, 137 gates and 1,731 taps; 15 meters are used. Service pipe are of cement-lined wrought-iron pipe, and connections are made with tin-lined lead pipe.

The population in 1880 was 13,845, and the daily consumption 750,000 gallons.

The works have cost $365,000. The bonded debt is $350,000 at 6 per cent. The expenditures in 1881 were, for maintenance, $2,298.84; for repairs and extensions, $1,828.18; for interest, $21,000. The receipts were $25,534.01.

The works are managed by six Water Commissioners. John Kimball is President and William M. Chase, Clerk. V. C. Hastings is the Supeintendent.

CCXXIX.—PLYMOUTH, N. H.

Plymouth, New Hampshire, in lat. 43° 45′ N., long. 71° 42′ W., is on the Pemigewasset River, which flows through a rugged region of granitic rock. The town was settled in 1754. In 1881 water-works were built by a private company, under the superintendence of W. F. Langdon. The supply is taken from two small streams fed by springs with a water-shed of about ½ square mile. An earth dam 13 ft. high and 8 ft. wide at top impounds the water in a small reservoir 90 ft. above the highest part of the village and 179 ft. above the lowest part. The supply main, 6,200 ft. long, is of 8-in. diameter, and the distributing pipes of 6 and 4 in., all of wrought iron and cement. Two miles of distributing pipe are laid, with 27 fire hydrants, 9 gates and 60 taps. The town pays $25 per year for each hydrant. Service pipes are of wrought iron, tarred.

The population is 1,100 and the daily consumption in 1881 was about 50,000 gallons.

The capital stock of the company is $30,000, and the works have cost about $25,000. There is no debt. The receipts are at present $1,500 per annum.

W. F. Langdon is the Superintendent.

CCXXX.—THREE RIVERS.

Three Rivers, Canada, in lat. 46° 22′ N., long. 72° 31′ W., is on the river St. Lawrence, at the mouth of the St. Maurice. Settled about 1620, it was incorporated as a city in 1857.

Water-works were built by the city in 1875 under the superintendence of P. N. Robichon and Henry Lor, taking the supply from the St. Lawrence and passing the water through 9 ft. of broken stone and coarse sand to a reservoir in the wharf on the river front. From this it is taken through an 8-in. wrought-iron pipe 120 ft. to a steam pump with 12-in. steam cylinder and 7-in. pump of 24-in. stroke, pumping directly into the mains, with 70 lbs. ordinary pressure and 145 lbs. fire pressure. The distribution is by 14 miles of cast-iron pipe made in Scotland, of 9, 6 and 4 in. diameter, with 53 fire hydrants, 36 gates and 1,700 taps. Two meters are in use. Lead service pipes are used.

The population in 1880 was 10,000, and the daily consumption 150,000 gallons.

The works have cost $125,000, which is the amount of bonded debt at 6 per cent. interest. The receipts to 1882 have been $70,000.

In 1880 the expenses of maintenance were $12,000 and the receipts $14,000.

O. Z. Hamel is the Superintendent.

CCXXXI.—EUREKA.

Eureka, Nevada, in lat. 39° 30′ N., long. 116° 10′ W., is in the Humboldt Mountain range. It was settled in 1864. Water-works were built in 1871 by Maj. W. W. McCoy as a private enterprise. The water of springs is collected in 6 tanks, holding 250,000 gallons, and distributed by gravity through one mile of 6-in. cast-iron pipe, with 20 fire hydrants, 30 gates and 700 taps. Ten meters are in use.

The town pays $3,000 per annum for use of hydrants. Wrought-iron pipe is used for services.

The population in 1880 was 5,000. The consumption is not known.

The works have cost $60,000. No further financial statements are given.

George F. Bliss is the Superintendent.

CCXXXII.—ALPENA.

Alpena, Michigan, in lat. 45° N., long. 83° 20′ W., is on Thunder Bay, Lake Huron, at the mouth of Thunder Bay River. It was incorporated as a city in 1871. Water-works were built by a private company in 1879, taking the supply from the bay. An inlet crib of fine timbers, bolted together and filled with stone, was sunk in 16 ft. water, 1¾ miles from shore. A 24-in. Wyckoff wooden pipe conveys the water from the crib to the pump well on the shore. Another pipe brings water to the well from a pond on Thunder Bay River. One Dixon duplex pump of 9-in. bore and 18-in. stroke, and 2 Holly rotary pumps, driven by 2 Leffell turbine wheels of 87½ and 50-in. diameter, pump directly into the mains, with ordinary pressure of 40 lbs. and fire pressure of 80 lbs.

The distribution pipes are Wyckoff's wooden pipe of from 16-in. to 4-in. diameter; 9½ miles are in use, with 80 fire hydrants and 370 taps.

The population is about 5,000 and the daily consumption 405,000 gallons. This quantity is only pumped by keeping waste pipes open all the time to insure constant circulation in the pipes.

Some trouble was at first experienced with the long suction pipe to the crib. An air pump was attached to exhaust air which entered, and it works successfully.

No financial statistics are given.

W. H. Johnson is Secretary of the company.

CCXXXIII.—BETHEL.

Bethel, Connecticut, in lat. 41° 25′ N., long. 73° 3′ W., is in a valley surrounded by high hills. It was incorporated as a borough in 1848. Water-works were built by the borough in 1878, after plans of W. B. Rider, C. E. An earth dam 200 ft. long and 20 ft. high, with a heart wall of rubble masonry, impounds a small stream running through a ravine, and forms a reservoir of 33 acres area and holding 84,000,000 gallons, 170 ft. above the town and 1½ miles distant from it.

The outlet chamber is in three compartments, the first containing 200 bushels of charcoal and the second 100 lbs. of sponge, through which the water is filtered and passes into the clear water division. This filter is reported as working well. From the chamber a 12-in. pipe conveys the water through the dam, and then, reduced to 10 in., leads to the town, about 2 miles. Distribution is by 3½ miles of cast-iron pipe of from 8 to 4-in. diameter, with 28 fire hydrants, 23 gates and 180 taps. Service pipes are of galvanized iron.

The population in 1880 was 2,731. The consumption is not known.

The works have cost $28,000. The bonded debt is $25,000 at 6 per cent. interest.

The cost of maintenance in 1880 was $160 and the receipts $1,898.

The works are managed by three Water Commissioners. Eli W. Gilbert, one of the Commissioners, is Secretary and acting Superintendent.

CCXXXIV.—SCHENECTADY.

Schenectady, New York, in lat. 42° 50′ N., long. 73° 52′ W., is on the Mohawk River. It was settled in 1684, created a borough in 1765 and incorporated as a city in 1798. Water-works were built in 1871 by a private company. A filter gallery, 100 ft. long 9 ft. wide and 9 ft. high, below low-water mark in the Mohawk River and along its shore, walled and arched with brick and surrounded with gravel, furnishes clear water, except at high stages of the river, when the yield is slightly turbid. Six Holly pumps of 10-in. bore and 14-in. stroke, operated by a Holly engine, force water directly into the mains, with an ordinary pressure of 50 lbs., and fire pressure of 110 lbs.

Distribution is by 11 miles of wrought-iron and cement pipe, of 12-in. to 4-in. diameter, with 132 fire hydrants, 56 gates, 500 taps and 20 meters. The city pays $71.88 per year for each hydrant.

The population in 1880 was 13,675, and the daily consumption was 1,000,000 gallons.

No financial statistics are furnished.

Charles Stanford, Jr., is Secretary of the company.

CCXXXV.—OWEN SOUND.

Owen Sound, Canada, in lat. 44° 30′ N., long. 81° 10′ W., is at the head of Owen Sound, an arm of the Georgian Bay, on the eastern side of Lake Huron. The town, which was settled in 1840 and incorporated in 1856, is in a valley half a mile wide and a mile and a half long, with hills 100 ft. high on three sides. The Sydenham River flows through the valley and the town.

Water-works were built by private enterprise in 1880, after the plans of William Kennedy, Jr. A copious spring flowing out of the rock 2½ miles from the town, and 177 ft. above it, is conveyed by 6-in., 8-in. and 10-in cast-iron pipes to a reservoir in the town on a blue clay hill, 165 ft. above the main street. It is in excavation, lined with broken stone and washed gravel, and holds 1,000,000 gallons.

Distribution is by 6 miles of cast-iron pipe of 10-in. to 6-in. diameter, with 20 fire hydrants, 8 gates and 175 taps. The town pays $50 per year for each fire hydrant. Service pipes are principally of lead, with some iron pipe for long distances. The population is about 5,000, and the daily consumption in 1881 about 50,000 gallons.

The works cost $35,000. The expenses of maintenance are very small. The receipts are not furnished. The works are owned by S. J. Parker and R. Notter. The town has the right to buy the works in 1891, at a valuation.

CCXXXVI.—TITUSVILLE.

Titusville, Pennsylvania, in lat. 41° 37′ N, long. 79° 48′ W., is on Oil Creek, on ground sloping gently to the south and surrounded by hills about 100 ft. high. It was incorporated as a city in 1866. Water-works were built by the city in 1873, under the superintendence of M. E. Bassett. The supply is taken from two wells 16 ft. in diameter and 22 ft. deep, dug in a gravel stratum near the creek. A Holly steam engine and pumps deliver the water directly into the mains, with an ordinary pressure of 40 lbs., and fire pressure of 65 lbs. A new rotary pump was put in in 1880. Distribution is by 9 miles of cast-iron pipes, of from 15-in. to 4-in. diameter, and some 2-in. wrought iron. There are 65 fire hydrants and 625 taps; 7 meters are in use. Service pipes are of wrought iron. The population in 1880 was 9,046 and the daily consumption 904,000 gallons.

The works cost $143,635. The interest, extensions and maintenance have cost $165,224.95 to Dec. 31, 1881. The gross receipts to that date have been $51,870.81. The bonded debt is $136,365, with interest at 8, 7, 6, and 5 per cent. The expenses of maintenance in 1881 were $9,052.58, and the receipts $8,414.21.

S. C. Roof is the Secretary and G. W. Angier the Superintendent.

CCXXXVII.—MIDDLETOWN, CONN.

Middletown, Connecticut, in lat. 41° 33′ N., long. 72° 40′ W., is on the Connecticut River, on ground rising from the river westward, 175 ft. in ¼ mile. It was settled in 1650 and incorporated as a city in 1784. Water-works were built by the city in 1866, after the plans and under the superintendence of George A. Bishop, C. E. An earth dam across a ravine impounds the drainage of ½ square mile in a reservoir covering 76 acres and averaging 10 ft. in depth, 168 ft. above the main business street of the city, and 45 ft. above the highest residence district. For filtering the water, a double wall of brick, filled in with stone and gravel, was provided. There is no way of cleaning this filter, and during the hot weather the water is better outside than in the filter. Distribution is by gravity, through 17¾ miles of pipe. The first pipe laid was of wrought iron and cement. Later extensions are of cast iron. There are 85 hydrants, 100 gates and 1,500 taps; 5 meters are used. Service pipes are of galvanized iron. The city pays from taxation $30 per year for double hydrants and $25 for single ones.

The population in 1880 was 11,781, and the daily consumption 750,000 gallons.

The cost has been as follows, from 1866 to 1882:

Construction	$227,408 16
Maintenance	39,984.21
Interest	153,851.51
Total	$421,243.88
Bonded debt (at 6 per cent. interest)	136,500.00
Receipts to 1882	170,040.57
Expenses in 1880	12,578.62
Receipts in 1880	15,412 29

The works are managed by a Board of Commissioners. John C. Broatch is the Secretary and Superintendent.

CCXXXVIII.—NEW BRIGHTON, PA.

New Brighton, Pennsylvania, in lat. 40° 44′ N., long. 80° 22′ W., on Beaver River, 3 miles from its junction with the Ohio River, is on three benches or terraces, each about 100 ft. high. It was settled about 1800.

Water-works were constructed in 1880, by Joseph Flannery, for a private company, taking the supply from springs under the bed of the Beaver River, a large caisson or well being sunk and tightly enclosed to keep out the river water, and pumping by a Worthington duplex pump driven by water power into a reservoir 312 ft. above the river. A steam pump built by Wilson, Snyder & Co. is used when the water power is not available. The reservoir holds 1,000,000 gallons.

Distribution is by 10 miles of cast-iron pipe of from 10-in. to 3-in. diameter, with 51 fire hydrants, 20 gates and 250 taps. Lead service pipe are used. The town pays $50 each per year for hydrants.

The population in 1880 was 4,214. The consumption is not stated.

The stock of the company is $50,000, and there is a bonded debt of $25,000, bearing 6 per cent. interest.

Further financial statements are not furnished.

R. E. Hoopes is the Treasurer and Superintendent.

(TO BE CONTINUED.)

The receipts of statistics, as follows, is acknowledged with thanks:

From Henry Scheld, statistics and water rates of the water-works of Yreka, California. From W. F. Langdon, agent, statistics and water rates of Plymouth, N. H., Aqueduct Co. From George P. Meneely, president, statistics and water rates of the water-works of West Troy, N. Y. From Jacob L. Kuehns, superintendent, statistics of water-works of York, Penn. From George H. Lincoln, superintendent, statistics and water rates of the water-works of Big Rapids, Mich. From John C. Broatch, secretary and superintendent, statistics of the water-works of Middletown, Conn. From the water commissioners, full set of reports, statistics and water rates of the water-works of Concord, N. H. From M. V. B. Rowley, manager, statistics of water-works of Lyons, N. Y. From E. Hibbard, clerk of Water Co., statistics and water rates of the water-works of Schenectady, N. Y. From W. D. Middleton, superintendent, report for 1880, water rates of the water-works of Camden, N. J. From Caleb Lombard, general agent, statistics of the water-works of Chelsea, Mass. From S. J. Parker, statistics of the water-works of Owen Sound, Canada. From S. C. Roof, secretary, reports for 1879 and 1881, statistics and water rates of the water-works of Titusville, Pa. From P. S. Williams, secretary, statistics of the water-works of Stroudsburg, Pa. From R. E. Hoopes, superintendent, statistics and water rates of the water-works of New Brighton, Pa. From S. D. Miller, superintendent, statistics and water rates of the water-works of Oil City, Pa. From Mark H. Richards, president of Gas & Water Co., statistics and water rates of the water-works of Pottstown, Pa. From F. F. Forbes, superintendent, the report of the water board of Brookline, Mass., for year ending Jan. 31, 1882. From S. P. Axtell, secretary, the eleventh annual report of the trustees of the water-works of Columbus, O.

LITERATURE.

Engineers and Mechanics Pocket Book, Forty-first edition, revised and enlarged, by CHAS. H. HASWELL, civil engineer, 1882.

It is scarcely necessary to say anything in commendation of this well known and fully appreciated hand book for engineers. The fact of the forty-first edition being called for indicates pretty clearly the value hitherto set upon it by such as have had occasion to consult its pages. Notwithstanding the increased number of such aids which have appeared since the issue of the first edition we have always kept a copy of this one on our shelves, as containing matter which, if found elsewhere, was still more accessible in point of arrangement and clearness of type and diction, in Haswell than in any of its rivals. The present edition of 720 pages, besides other matter, which has been revised and rearranged, to the exclusion of matter out of date, is peculiarly rich in all that pertains to steam engines and boilers, whether stationary or locomotive, simple or compound; and we recommend the "Pocket Book" as one entitled to a prominent place in the library of all interested in the mechanic arts.